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ON *DOCIOSTAURUS TARTARUS* (STSCHELKANOVZEV, 1909) (ORTHOPTERA, ACRIDIDAE)

By B. P. Uvarov, C.M.G., D.Sc., F.R.E.S.
(*Anti-Locust Research Centre*)

Redtenbacher (1889, *Wien. ent. Ztg.* 8 : 24), in a list of Orthoptera from Turkmenia, mentioned *Stauronotus tartarus* Saussure. This was a manuscript name given by Saussure to a species from Central Asia, and it has never been published. Stschelkanovzev (1909, *Izv. Imp. Varshav. Univ.* 1909 : 34, sep. repr.) had before him a series of specimens from Central Asia, originally labelled by Saussure as *S. tartarus*, as well as some other specimens from the Caucasus, and he gave the first description of the species, thus becoming its author, although he called it *tartarus* Saussure. Recently, Tarbinsky (1940, *Saltat. Orth. Insects Azerbaidzhan* : 182, 185, 186) reported the results of his re-examination of the typical series of *S. tartarus* Stschelkanovzev, which is preserved in the Moscow Zoological Museum. The series consisted of the following specimens :—

A. Forty-one specimens from several localities in Central Asia, all labelled "*tartarus* Saussure det." and belonging to a species distinct from those under B and C.

B. One male and one female from Kislovodsk, Northern Caucasus, belonging to *Dociostaurus anatolicus* (Krauss) and labelled "*S. tartarus* Sauss. Stschelk. det."

C. One female from the Geoktchai steppe, Transcaucasia, belonging to *D. maroccanus* (Thunberg), labelled "*S. tartarus* Sauss. Stschelk. det."

It was only to be expected that Stschelkanovzev's description based on such mixed material was anything but clear. However, the species, to which the specimens mentioned under A above belonged, has been recognized from that description and separated from others by me (Uvarov, 1921, *Bull. ent. Res.* 11 : 399, 403) under the name *D. crucigerus tartarus* Stschelkanovzev. Tarbinsky (1930, *Konowia* 9 : 187) has proved that *tartarus* is specifically distinct from *crucigerus* Rambur, and more recently (Tarbinsky, 1940, *loc. cit.* : 187) proposed to credit the name *tartarus* to me, instead of Stschelkanovzev. His reasoning was based (1) on the fact that Stschelkanovzev's original description does not agree with the present conception of *tartarus* ; and (2) on the assumption that the description was based only on the specimens listed above under B (*D. anatolicus*) and C (*D. maroccanus*). The first reason is not acceptable since hardly any old description would satisfy modern requirements, and the description in question is merely vague enough to fit a mixture of three species. As for the second argument, we have to accept Stschelkanovzev's statement that his description was based "on a study of both the Caucasian and the Turkestan specimens."

Therefore, Stschelkanovzev is to be regarded as the author of *tartarus*, and the only point to decide is to which of the three species comprised in the typical series this name should be applied. This problem has been actually solved by Tarbinsky himself (although he did not appear to realize it) since he has formally designated one specimen of the original series studied by Stschelkanovzev as the type ; this was a male labelled "vallée de Sarafshan, 26, *tartarus* Sauss det." This action makes *tartarus* Stschelkanovzev quite unambiguous. A brief diagnosis of the species has been provided by me (Uvarov, 1921, *loc. cit.*), and more detailed descriptions will be found in the following publications : Uvarov, 1925, *Saran. evrop. chasti SSSR i zap. Sibiri* : 61, 62 ; Uvarov, 1927, *Saran. sredn. Asii* : 88, 91, figs. 88, 89 ; Tarbinsky, 1930, *Konowia* **9** : 187, fig. 6 ; Tarbinsky, 1940, *Saltat. Orth. Ins. Azerbaidzhan* : 28, 182, 186.

The geographical range of *D. tartarus* covers the semi-desert plains of the Aralo-Caspian basin and extends into Northern Persia, Iraq, Afghanistan and Baluchistan. My previous record (Uvarov, 1921, *loc. cit.*) from North Africa was erroneous.

NOTES ON URTICATING LEPIDOPTEROUS LARVAE BECOMING OF SOME LOCAL MEDICAL IMPORTANCE

By R. A. Davis, M.Sc., F.R.E.S.

While serving in the army, the writer had occasion to observe two instances of the production of urticarial weals by lepidopterous larvae, and on the first occasion this occurred on a large scale among troops and civilians.

A certain camp was situated among pine trees at Beirut, in the coastal region of the Lebanon. Periodical outbreaks of processional caterpillars of the type which forms silken nests in the tops of pine trees are known to occur in this area, and according to a local biologist of the American University there is an approximate ten-year cycle. The species concerned resembles that species with similar habits which occurs in many parts of the South of France in pine forests. Unfortunately, the special circumstances of the writer prevented his being able to identify the species at that time, or even to keep specimens, but information is now being sought from the University mentioned.[1]

Early in 1944, many soldiers began to complain of severe irritation and urticarial weals, and also that long "streams" of these larvae had passed over blankets and towels hung about the camp. Later, even individuals situated well down-wind from the trees, where no larvae had been seen, also complained of the urticaria. The outbreak reached such an intensity that entomological information and advice was sought by the medical authorities from the writer's unit.

Similar symptoms occurred among civilians of the American University residing near groups of pine trees, but in these cases actual contact of the caterpillars with clothing, etc., had apparently occurred in every instance.

While serving in the Gold Coast in the latter half of 1944, the writer had two personal experiences of the irritation that can result, this time caused by larvae of Limacodidae. Again, circumstances were such that more exact identification than this was not possible, but the family is definitely that stated.

When "dipping" among swamps for larvae of *Anopheles funestus* Giles, the writer suddenly felt a sharp stinging pain above the right knee, which, as shorts were worn, continually came in contact with the vegetation. Examination of the plant against which he had brushed, revealed two green-coloured larvae of the Limacodidae.

The pain and irritation spread rapidly, a weal extended up the thigh, and a slight pain was felt in the groin. This lasted for about two hours, after which the symptoms had entirely disappeared.

---

[1] The species is probably the one known as the "Pine Processionary Moth." Mr. W. H. T. Tams informs me that the name of this insect is *Thaumatopoea pityocampa* Schiff, family Thaumatopoeidae.—G. Talbot.

On the second occasion, the hand holding the dipper brushed against a larva, seen at once after contact. The larva was apparently of the same species as before. A Kroo "boy" rejoicing in the name of "Brandy" who was employed as general labourer and porter at once volunteered to cure the symptoms. He took a larva between two leaves, squashed it, and rubbed the resulting juices on the affected hand, saying that the pain would soon disappear.

Whether or not this is statistically significant, it is certain that the pain did in fact disappear within half an hour, whereas previously it lasted for two hours.

Is this an instance of belief in "the hair of the dog that bit you," or is it a piece of knowledge of a true biological phenomenon ? It may be that the larva manufactures anti-bodies of some kind, which can thus neutralise the effect of its own toxins. It is suggested that there is room for further study in this field. "Brandy," when questioned, said that "his father had told him about it." Pressed further, he said that "his grandfather had told his father," but be either was incapable of going beyond this, or would not do so.

BOOK NOTICES.

Survey of Askham Bog. By Bootham School, York. 4to. London (Bannisdale Press), 1946. Pp. 75, map, text illust.

Askham Bog is a small area of swampy ground lying to the south-west of the town of York. The area was surveyed by three masters of Bootham School in 1879, and the present report is the outcome of a recent survey made by over ninety pupils directed by their master, who have thus been able to assess the changes which have taken place.

The geology, botany, entomology, birds, vertebrates, and invertebrates are dealt with, and followed by an ecological report and summary. A complete list is given of the butterflies found at the Bog, but it was not possible to include a comprehensive census of the moths and other insects. Comparisons are made throughout with the 1879 report.

The observers are to be congratulated on their careful observations and for making them available in this form, which should serve as an inspiration to naturalists associated with other areas of similar biological interest.

GENETIC BEHAVIOUR OF THE RED FORM OF *DYSDERCUS DISCOLOR* WALKER IN THE WEST INDIES (HEMIPTERA).

By F. A. Squire.
(*Department of Agriculture, Sierra Leone*)

Mendes in Brazil carried out breeding experiments with the melanic form of *D. mendesi* Bloete and concluded that it is determined by a single pair of recessive factors, the normal form being incompletely dominant over the melanic. There seems to be a lower egg fertility in the crosses MM (normal type) × MM, and mm (recessive type) × mm. The highest fertility was obtained in the crosses MM × mm, Mm × mm, and MM × Mm. Thus there is an excess of heterozygous over homozygous individuals. The heterozygous individuals are phenologically intermediate between the melanic and the normal form. It is therefore a case of incomplete dominance.

In St. Vincent *D. discolor* Walker likewise has two forms—the common one with black hemelytra and the red winged form. In addition, intermediate forms ranging from red to black are common in large populations. In order to determine the nature of this variant, the following breeding experiments were carried out in St. Vincent.

Started with ♀B × R♂. The female was bred from black forms in the laboratory, the red was taken from the field.

Progeny.

R (Red), I (Intermediate), B (Black), EM (Egg mortality) 32·4%
45 1 49 NM (Nymphal ,,) 37·9%

These were mated in the following way :—

6 pairs B × B ; 6 pairs R × R ; 3 pairs B♀ × R♂ ;
3 pairs R♀B♂.

The progeny is summarised below.

BLACK PAIRS.

No. of pair	No. of eggs	Percentage egg mortality	Percentage nymph mortality	R	I	B
1	216	32·8	37·9	0	3	87
2	187	37·4	25·7	2	1	84
3	253	40·3	31·7	1	1	101
4	207	41·6	48·3	0	0	63
5	111	37·8	28·9	0	0	50
6	91	68·1	34·4	0	0	19
		43·0	34·5	3	5	404

RED PAIRS.

No. of pair	No. of eggs	Percentage egg mortality	Percentage nymph mortality	R	I	B
37	159	63·5	33·3	26	1	5
39	66	86·3	22·2	5	0	2
40	265	83·3	31·1	23	0	8
41	120	62·5	31·3	26	1	8
42	118	89.7	33.3	7	1	0
38	Female died;	no progeny.				
		77·1	30·2	87	3	23

B♀×R♂.

No. of pair	No. of eggs	Percentage egg mortality	Percentage nymph mortality	R	I	B
34	281	40·2	43·8	52	4	40
32	224	49·1	39·8	32	0	42
Orig. pr. 27	228	33·7	30·8	45	1	49
		41·0	38·1	129	5	131

R♀×B♂.

No. of pair	No. of eggs	Percentage egg mortality	Percentage nymph mortality	R	I	B
31	99	66·6	39·3	8	1	9
33	124	41·9	41·6	19	4	19
35	182	15·9	41·1	43	1	46
		41·5	40·7	70	6	74

These results were submitted for interpretation to Mr. J. B. Hutchinson, Head of the Genetical Department of the Empire Cotton Growing Corporation's Research Station in Trinidad, who reports as follows :—

> "The basic genetic situation is quite simple : Red is dominant over black and all the reds tested have been heterozygous. Red × black therefore gives equal numbers of red and black and black pairs give black only. Red × red gives three red to one black. The data from the black pairs indicates a very rapid mutation rate from black to red. Out of 412 individuals which should have been homozygous black in constitution, there were 3 red and 5 intermediate. It is not possible to say what the genetic constitution of the intermediates is without breeding tests, but there seems no reason to doubt that the 3 red individuals at least were mutations from homozygous black to heterozygous red.
>
> "There seems to be no great difference in nymph mortality in the different crosses, but there are considerable and important differences both in number of eggs laid and in egg mortality. All red females behaved the same way in number of eggs laid and taking all red females against all black females, blacks averaged 200 eggs

per female and reds only 142. Egg mortality is inconsistent in one remarkable respect. Red pairs suffered nearly double the egg mortality of black pairs, and I therefore expected to find that red × black when red was female would also show a high egg mortality, whereas reciprocal crosses (black as female) would show an egg mortality similar to the black pairs. This is not borne out, and the egg mortality in both red × black crosses is very similar to that in the black pairs. This can be explained if the egg mortality were due to very low viability of eggs expected to give rise to homozygous red. I then inspected the ratio of red to black in the red pairs, and it is, as you will have observed, very close to the expected 3 red to 1 black. This entirely rules out the hypothesis that the high egg mortality in red pairs is due to high mortality of homozygous reds, as any differentiation in mortality would result in considerably less than the expected 3 reds to every one black. I can only make one suggestion on this count, and that is that the egg mortality from the red female × black male cross may accidentally have been unusually low. The 3 pairs in this cross suffered respectively 67, 42 and 16 per cent. egg mortality. Sixteen per cent. is a long way the lowest egg mortality in the whole series and may perhaps have been due to fortuitous combination of favourable circumstances."

REFERENCE.

Mendes, L. O. T., 1938, Genetics of *Dysdercus*. *J. Heredity* **29** : 387–389.

THE COMPARATIVE ANATOMY OF THE INTERNAL GENITALIA OF SOME TINEOIDEA (LEPIDOPTERA, GRACILLARIIDAE–TISCHERIIDAE)

By Joseph L. Williams, A.B., A.M., Ph.D., F.R.E.S.
(Department of Zoology, Howard University, Washington, D.C., U.S.A.)

This investigation is one of a series conducted with the hope of establishing an intermediate form between monotreme and diplotreme Lepidoptera. At the present time monotremes are considered to be those Lepidoptera in which the single genital orifice of the female opens on the ninth abdominal sternum. In diplotremes the female is considered to have two genital openings. The first, which is situated on the eighth abdominal sternum, functions only as a copulatory orifice. The second opening, situated on the ninth abdominal sternum, functions for the exit of eggs. An anus is thought to exist in both monotreme and diplotreme Lepidoptera.

Under the present taxonomic system monotremes are classed as the most primitive of Lepidoptera. All members of the suborder Jugatae, according to Busck (1931), are monotremes. The suborder Frenatae contains all of the diplotremes and a few families of monotremes. The most primitive members of the suborder Frenatae belong to the monotreme group. It, therefore, appears from this relationship that monotremes are direct ancestors of diplotremes.

Petersen (1900) may be considered the father of the current theory that diplotremes evolved from monotremes. In discussing this problem he considers *Psyche unicolor* Hfm., which is a diplotreme, as representing an intermediate type in the phylogenesis of diplotremes from monotremes. In formulating this theory Petersen, no doubt, was influenced by Cholodkowsky (1885), who was first to point out the single reproductive opening of *Nematois metallicus* Poda. Cholodkowsky was, therefore, the first to suggest that monotremes possess independent genital and anal openings.

Williams (1941*a*) pointed out that the so-called genital openings in the typical American monotremes, *Tegeticula alba* Zeller (=*yuccasella* Riley) and *Prodoxus quinquepunctella*, are not genital in their total function. In both species the egg-exit duct and the terminal digestive duct fuse to form a double functioning (cloacal) duct. Busck (1931) and Philpott (1926) failed to recognise this fact. Richards (1933) made a study of *Incurvaria russatella* Clemens and was the first to question the presence of an anus in monotremes. He finally concluded, doubtfully, that an anus is present in *I. russatella.*

In diplotremes the opening on the eighth abdominal sternum leads into the bursal cavity by way of the bursal duct. The bursal cavity communicates with the vagina by means of the bursal duct. The seminal duct varies in length and diameter according to the species. The so-called bursa copulatrix of monotremes has no opening except that which communicates with the vagina. This communicating duct appears to resemble the bursal duct of diplotremes. Although a cloacal duct or a cloacal receptacle is present in diplotremes, the bursa copulatrix has no connection with the egg-exit duct except by way of the seminal duct. The so-called bursa copulatrix of monotremes, for the present, should be called a spermatophore-containing receptacle, for it may not be homologous to the bursa copulatrix of diplotremes. It is, therefore, desirable to establish a more sound relationship between monotremes and diplotremes than that presented by Petersen. If this can not be done we must, therefore, assume that neither is ancestral to the other.

Materials and Methods.

Mines of *Lithocolletis fitchella* Clemens, *Tischeria badiiella* Chambers, *T. tinctoriella* Chambers and *T. malifoliella* Clemens were collected by Dr. Emlen P. Darlington near the central part of New Jersey in the late fall of 1944. He reared these mines through the winter under his expert care and sent them to the author late in April, 1945. In following the suggestions of Dr. Darlington, about a quarter of an inch of cold boiled water was placed in sterile one-half pint milk bottles. A perforated tightly fitting cardboard disc was placed in each bottle to rest 1 centimeter above the surface of the water. A piece of glass tubing was fitted through each disc and extended from the surface of the water to 2 or 3 inches above the mouth of the bottle. The purpose of this tube was to replace water lost due to evaporation. A layer of special cotton, which does not absorb water, was placed on each disc in the bottle. Mines of each species were placed on the cotton in separate bottles. The bottles were plugged with cotton which surrounded the tubes, projecting beyond their mouths. The bottles were kept in a room that was well lighted, but they were not allowed to be exposed to direct sunlight.

The adults began emerging on the 21st of May and continued until the 5th of June. Freshly killed specimens were dissected and whole mounts prepared according to the method described by Williams (1943*b*).

Reproductive Organs.

Male.—The testes are fused in all species and enclosed in a single testicular sac. The shape of the testes in freshly dissected material is characteristic for the various species. The conventional methods of fixation and mounting distort this characteristic. The fused testes of *L. fitchella* are definitely oval and measure approximately ·8 mm. along the long axis and ·5 mm. along the short axis. The testes of *T. badiiella* are fused, but the outline of each can be recognised through the testicular sac. The single body is somewhat flattened and measures approximately ·35 mm. along the long axis, ·2 mm. along the short axis. The testes of *T. tinctoriella* form a more or less circular body. The diameter of this body is about ·35 mm. The testes of *T. malifoliella* form a body similar to that of *T. tinctoriella* (figs. 1–4, B).

The seminal vesicles (fig. 4, C) are expanded portions of the vasa deferentia and are situated between the testes and the ejaculatory duct.

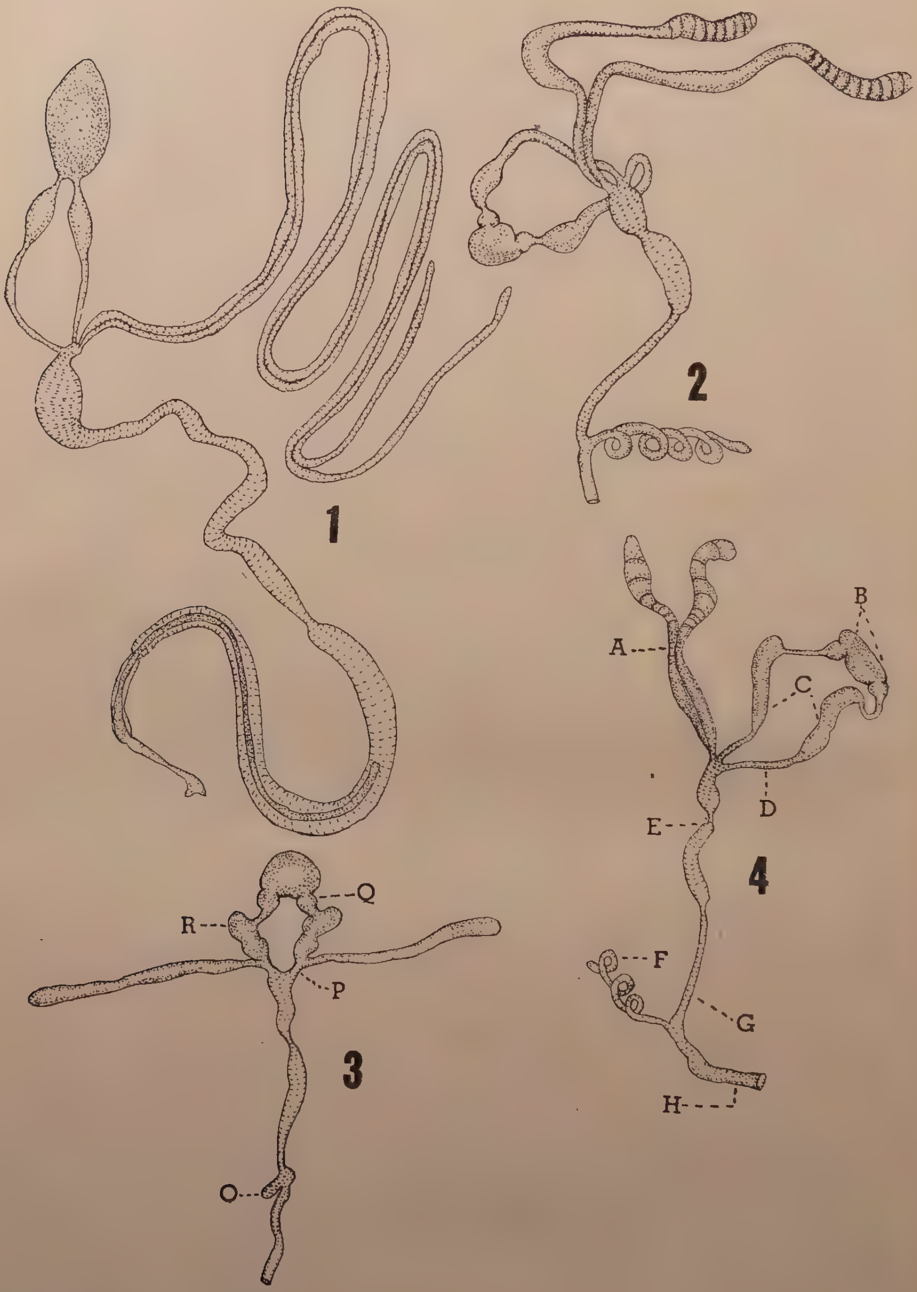

FIG 1. Male genital system of *Lithocolletis fitchella* Clemens. FIG. 2. Male genital system of *Tischeria malifoliella* Clemens. FIG. 3. Male genital system of *T. tinctoriella* Chambers. FIG. 4. Male genital system of *T. badiiella* Chambers.

The seminal vesicles of *L. fitchella* are bulb-shaped and each is sharply distinguished from the testes and vas deferens (fig. 1). They are about ·7 mm. long with a diameter of ·2 mm. The seminal vesicles are nearer to the testes than they are to the ejaculatory duct in this species. These organs are flask-shaped in *T. badiiella* and each occupies about one-half the length of the vas deferens. They are at about equal distances from the testes and the ejaculatory duct. Each seminal vesicle is about 1 mm. long and ·25 mm. in diameter across the testicular end. The end which is adjacent to the ejaculatory duct is only ·15 mm. in diameter. The seminal vesicles of *T. tinctoriella* are oval and each measures about ·25 mm. along the long axis and ·16 mm. along the short axis (fig. 3, R). The seminal vesicles in *T. malifoliella* resemble those of *T. badiiella*, but are less flask-shaped. They are more or less oval and are situated nearer to the testes than are those of *T. badiiella*. Each organ is about ·33 mm. along the short axis (fig. 2).

The vasa deferentia of *L. fitchella* are filamentous both above and below the seminal vesicles (fig. 1). The seminal vesicles of *T. badiiella* form a cup-like structure immediately below the testes like those of *T. tinctoriella* (fig. 3, Q). The remaining portions of the ducts are filamentous both above and below the seminal vesicles. These structures are characteristic and are present in the species presented belonging to this genus (fig. 4, D). The vasa deferentia of *T. tinctoriella* are filamentous between the cup-like structures and the seminal vesicles, but are saccular below the seminal vesicles. The small sacs form filamentous tubes posteriorly which empty into the ejaculatory duct. These small sacs may be a part of the seminal vesicles (fig. 3). The vasa deferentia of *T. malifoliella* are filamentous between the cup-like structures and the seminal vesicles, but are somewhat larger tubes below the seminal vesicles. The ducts narrow proximally before they enter the ejaculatory duct (fig. 2). The length of the vasa deferentia between the cup-like structures of the testes and the seminal vesicles is about ·5 mm. in *T. badiiella*, ·1 mm. in *T. tinctoriella* and ·2 mm. in *T. malifoliella*.

The ejaculatory duct in *L. fitchella* is a slender tube and is about 7 mm. long. Its distal portion is expanded just below the entrances of the vasa deferentia and the accessory glands. This expanded part is 1 mm. long. Below this expansion the duct narrows, but forms a second expansion about ·3 mm. below the first. The second expansion is 2 mm. long. Below this second expansion the duct narrows again and ends at the base of the penis. The distal end of the duct does not bifurcate to form an obvious duplex ejaculatory duct which is so common among Lepidoptera (fig. 1). The ejaculatory duct of *T. badiiella* is about 2·5 mm. long. It forms a distal expansion into which open the accessory glands and vasa deferentia. The duplex ejaculatory duct is not obvious. Below this expansion is a second. The duct narrows below the second expansion and continues to the penis. A coiled gland-like structure enters the duct just before it joins the base of the penis (fig. 4, F and G). The ejaculatory duct of *T. tinctoriella* is a slender tube measuring about 2 mm. in length. The distal part is expanded like those of the other species discussed.

The tube narrows posteriorly and expands into a second expanded portion. The second expansion narrows posteriorly into a slender portion which enters the penis. A sac-like structure (fig. 3, O) enters the ejaculatory duct a short distance before it joins the penis. This structure may function like the coiled gland-like structure of *T. badiiella* (fig. 4). The ejaculatory duct of *T. malifoliella* is about 2·5 mm. long and is similar to that of *T. badiiella.*

The accessory glands of *L. fitchella* are slender tube-like structures and are about 17 mm. in length. The two glands are bound together by a connective tissue except for a few millimetres at the distal ends. The binding, however, does not obscure the identity of the independent glands (fig. 1). The accessory glands of *T. badiiella* are tube-like structures with segmented club-like bodies at their distal ends. The total length of each gland is about 2·5 mm. The club-like distal end measures about ·5 mm. (fig. 4). The accessory glands of *T. tinctoriella* are tubular with expanded distal ends. The expanded ends do not appear to be segmented. The total length of each gland is about 1·5 mm. (fig. 3). The accessory glands of *T. malifoliella* are similar to those of *T. badiiella.* Each gland is about 2 mm. long (fig. 2).

The penis, which is a part of the external genitalia, is not the concern of this study. Penile differences, however, can be distinguished.

Female.—There are two ovaries in all species and each consists of four polytrophic ovarioles. The distal ends of the ovarioles composing each ovary are held together by a short ovarian ligament. Each ovarian tube of *L. fitchella* contains on the average between nine and ten well-developed eggs. The more mature eggs are at the bottom of the tube and they decrease in size towards the distal end. Above the most distal well-formed egg are very immature eggs that can scarcely be distinguished (fig. 5). Each ovarian tube of *T. badiiella* contains on the average between seven and eight well-formed eggs. They decrease in size from the bottom towards the distal end ; indistinguishable ova are present in the distal ends of the tubes of this species also (fig. 7). Each ovarian tube of *T. tinctoriella* contains an average of fifteen ova (fig. 6). In *T. malifoliella* each ovarian tube contains on the average between nine and ten ova (Fig. 8).

The lateral and median oviducts of *L. fitchella* are tubular and each measures about ·5 mm. in length. In *T. badiiella* the lateral oviducts are shorter than the median oviduct. Each of the former measures about ·2 mm. in length and the latter about ·5 mm. These structures in *T. tinctoriella* and *T. malifoliella* are similar to those of *T. badiiella.* The diameters of these structures are about the same and measure approximately ·1 mm. (fig. 5, 6, 7 and 8).

The bursa copulatrix of *L. fitchella* is connected to the vagina by means of a seminal duct. The bursa also has an independent opening. These characteristics definitely put this species in the diplotreme class. The seminal duct expands into a large sac (fig. 5, U) which is nearer to the bursa copulatrix than it is to the vagina. The duct expands into another smaller sac (fig. 5, V) which is nearer to the vagina than it is to the bursa copulatrix. Expansions of the seminal duct are quite

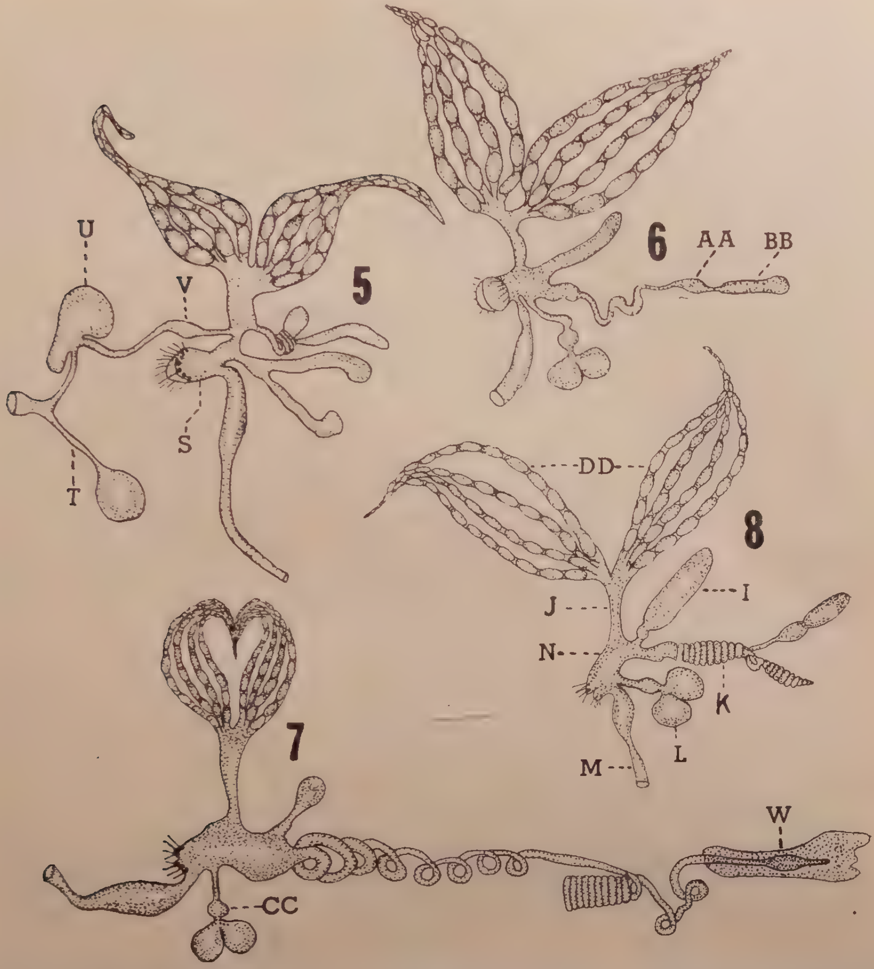

Fig. 5. Female genital system of *L. fitchella* Clemens. **Fig. 6.** Female genital system of *T. tinctoriella* Chambers. **Fig. 7.** Female genital system of *T. badiiella* Chambers. **Fig. 8.** Female genital system of *T. malifoliella* Clemens.

common among Lepidoptera. *T. badiiella, tinctoriella* and *malifoliella* have no seminal ducts connecting the bursae and vaginae. These species, therefore, are true monotremes. The so-called bursa copulatrix, which should be referred to as the sperm-containing receptacle (fig. 8, I) of these monotremes is an extension from the vagina. The saccular portion is connected to the vagina by means of a duct. No attempt is made to describe these structures for all of the species were virgin. The author is of the opinion that a more accurate description is possible when the sperm-containing receptacle has a spermatophore enclosed within its walls (figs. 6, 7 and 8). In many instances, and this is especially true for some of the Psychidae, a more accurate description of the bursa copulatrix and the seminal duct of diplotremes is possible if pairing has occurred.

The spermatheca of *L. fitchella* is composed of a sac and gland which communicates with the vagina by means of the spermathecal duct. There are three or more coils present in the spermathecal duct. The entire structure measures about 1·2 mm. from the base of the duct to the tip of the gland (fig. 5). The spermatheca of *T. badiiella* is composed of a long coiled spermathecal duct. The distal portion is surrounded by a glandular tissue (fig. 7, W). Within this glandular tissue the terminal end of the spermathecal duct expands into a saccular body. The total length of the spermathecal duct and gland is about 3·5 mm. In *T. tinctoriella* the spermathecal duct expands into a reservoir-like structure before entering the vagina. The distal end of this reservoir narrows to form a slender tube. This tube coils two or three times and expands into a sac-like structure (fig. 6, AA). The distal end of this sac narrows into a short slender tube which enters at the base of a tube-like glandular structure (fig. 6, BB). The length of the entire spermathecal structure is about 1·8 mm. The spermathecal duct of *T. malifoliella* enlarges basally before entering the vagina. The distal end of this enlarged portion narrows into a tightly coiled tube. The distal end of the tube expands into a small sac. At the distal end of this sac is an oval gland-like structure. The length of the spermatheca, as illustrated, is about 2 mm. If the spermathecal duct were uncoiled the total length would be much greater (fig. 8).

The accessory glands of *L. fitchella* converge proximally to enter a reservoir. The reservoir narrows proximally to form a duct which enters the egg-exit duct. The glands are more or less tubular, but their distal ends are enlarged into sac-like structures. The reservoir and duct together measure about ·5 mm. Each limb of the gland measures about 1 mm. in length. The accessory glands of the members of the genus *Tischeria* examined are similar. The glands are saccular and are situated at the distal end of the accessory-gland duct. They converge at their proximal ends to form a short slender duct. The distal end of this duct expands into a reservoir-like structure (fig. 7, CC). The reservoir narrows proximally to form a slender duct which enters the egg-exit duct. The total length of the accessory-gland apparatus varies between ·5 mm. to 1 mm. (figs. 6, 7 and 8).

The recto-genital (cloacal) duct (fig. 5, S) is present in every species examined. This duct functions as an outlet for the digestive and reproductive systems. It also functions as a copulatory duct in monotremes.

Discussion and Conclusion.

This investigation has failed to give a satisfactory explanation of the phylogenesis of diplotreme from monotreme Lepidoptera. This phylogenetic question is by no means new. Imms (1938) claims that the copulatory orifice, bursal duct and seminal duct are new structures of diplotremes differentiated from the bursa copulatrix (spermatophore-containing receptacle) of monotremes. The seminal duct, therefore, separates the bursa copulatrix from the rest of the reproductive system in diplotremes. He also claims that the seminal duct is considerably lengthened and is of an exceedingly narrow calibre in the highest diplotremes. The separation of the bursa from the vagina, according to

Imms, is exhibited in the least modified condition in certain of the PSYCHIDAE. Petersen (1900) suggests that in diplotremes degrees of development are in accordance with the position of the seminal duct on the bursa copulatrix. The most primitive diplotreme has this duct arising at the base of the bursal duct. The most advanced diplotreme has the duct arising from the top of the bursal sac. Intermediate stages are, therefore, in between these two extremes. The position as well as the length of the seminal duct in *Solenobia walshella* Clemens, *Eurukuttarus confederata* Grt. (Williams, 1944) and *Fumea casta* Pall. (unpublished) resemble that in *Psyche unicolor*. The length of the seminal duct in *Thyridopteryx ephemeraeformis* Haworth (Williams, 1944) and some members of the genus *Oiketicus* (unpublished) is as great as, or in some cases greater than, those of the higher diplotreme Lepidoptera. The position of the seminal duct on the bursa copulatrix (Williams, 1941*b*) as well as its diameter are characteristics which vary with the species. The establishment of an intermediate form based on these characteristics is not sound.

It has been suggested that the cloacal duct (Williams, 1941*c*) might serve as a key to the phylogenetic relationship between monotremes and diplotremes. Further study has cast doubt upon this assumption. Busck (1931) considers all members of the suborder JUGATAE to be monotremes. He divides this group into those in which the female has a strongly chitinised ovipositor and those in which the ovipositor is soft and bilobed. The ERIOCRANIIDAE belong to the first and the MICROPTERYGIDAE, HEPIALIDAE and MNESARCHAEIDAE belong to the second. The FRENATAE, according to Busck, are composed of both monotremes and diplotremes. Monotremes of this group, on the basis of the ovipositor, are divided as in the JUGATAE. The families NEPTICULIDAE, TISCHERIIDAE and OPOSTEGIDAE have soft ovipositors in the females and are direct descendants, according to Busck, from micropterygid stock. The families INCURVARIIDAE, PRODOXIDAE, ADELIDAE, CRINOPTERYGIDAE and HELIOZELIDAE have hard piercing ovipositors and are derived from eriocraniid stock. This present investigation reveals that the monotremes described have soft ovipositors and a rather short cloacal duct. The INCURVARIIDAE (Williams, 1941*a*) have hard piercing ovipositors and a rather long cloacal duct. The relationship between the members of the JUGATAE and those of the FRENATAE is so close that the term monotreme is suggested to cover all Lepidoptera in which the female has only one abdominal opening with, of course, its divisions. Attempts in this direction have been made by Busck and by Richards (1933). Busck refers to monotremes as aculeate Microlepidoptera and Richards as the Adeloids.

Diplotremes are similar to monotremes in that the second abdominal duct is cloacal. They differ from monotremes in that pairing does not occur by way of this duct. Again the presence of the seminal duct is another diplotreme characteristic. The cloacal duct in members of the PSYCHIDAE is much longer than it is in members of the LASIOCAMPIDAE and other higher diplotremes. It is not as long as in members of the INCURVARIIDAE investigated, yet it is more distinct than that of the

TISCHERIIDAE. The comparative anatomy of the internal genitalia of Lepidoptera, therefore, fails to give any evidence of a direct phylogenetic relationship between monotremes and diplotremes. This statement is supported by Busck, who claims that no species in the transition stage has survived. If transition stages have existed, then the truth of phylogeny must be obtained from ontogeny. Perhaps monotremes and diplotremes had a common ancestor sometime during the past. Evidence from the comparative anatomy of the internal genitalia indicates that each is a distinct line and neither is the ancestor of the other.

SUMMARY.

1. This investigation is one of a series conducted with the hope of establishing an intermediate form between monotreme and diplotreme Lepidoptera.

2. The material consisted of fresh specimens, which were dissected and fixed according to the method indicated.

3. The comparative anatomy of the internal genitalia of one member of the family GRACILLARIIDAE and three of the family TISCHERIIDAE is given with a discussion of the comparative anatomy of the internal genitalia of previously described species.

4. On the basis of this and previous studies there is no evidence to support the theory of direct ancestral relationship between the monotreme and diplotreme groups.

5. The term monotreme is suggested for all Lepidoptera in which the female has one abdominal opening and diplotreme for those in which the female has two abdominal openings.

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REFERENCES.

BUSCK, A., 1931, On the female genitalia of the Microlepidoptera and their importance in the classification and determination of these moths. *Bull. Brooklyn ent. Soc.* **27** : 199–211, 5 pls.

CHOLODKOWSKY, N., 1885, Uber den Geschlechtsapparat *Nematois metallicus* Poda. *Z. wiss. Zool.* **42** : 502.

IMMS, A. D., 1938, *A general Textbook of Entomology.*

JONES, F. M., 1927, The mating of the PSYCHIDAE (Lepidoptera). *Trans. Amer. ent. Soc.* **53** : 293–314.

PETERSEN, W., 1900, Beiträge zur Morphologie der Lepidopteren. *Mem. Acad. Sci. St-Pétersb.* **9** (6).

——, 1904, Die Morphologie der Schmetterlinge und ihre Bedeutung für die Artbildung. *Mem. Acad. Sci. St-Pétersb.* **16** (8).

——, 1907, Über die Spermatophoren der Schmetterlinge. *Z. wiss. Zool.* **88** : 117–130, 1 pl.

PHILPOTT, A., 1927, Notes on the female genitalia in the Micropterygoidea. *Trans. ent. Soc. Lond.* **75** : 319–323, 1 pl.

RICHARDS, A. G., Jr., 1933, Morphology of the female reproductive system of *Incurvaria russatella* Clem. *J. N. Y, ent. Soc.* **41** : 167–184, 5 pls.

SNODGRASS, R. E., 1931, Morphology of the insect abdomen. Part 1. General structure of the abdomen and its appendages. *Smithson. misc. Coll.* **85** : (6) 1–128.

WILLIAMS, J. L., 1938, The mating of *Ephestia kuehniella* Zeller and its results. *Ent. News.* **49** : 104–107 ; 121–126.

——, 1939, The occurrence of spermatophores and their measurements in some British Lepidoptera. *Trans. Soc. Brit. Ent.* **6** : 137-148.

——, 1940, The anatomy of the internal genitalia and mating behavior of some Lasiocampid moths. *J. Morph.* **67** : 411–437.

——, 1941*a*, The internal genitalia of Yucca moths and their connection with the alimentary canal. *J. Morph.* **69** : 217–222.

——, 1941*b*, The relation of the spermatophore to the female reproductive ducts in Lepidoptera. *Ent. News.* **52** : 61–65.

——, 1941*c*, The internal genitalia of the evergreen bagworm and the relation of the female genital ducts to the alimentary canal. *Proc. Pa. Acad. Sci.* **15** : 53–58.

——, 1943*a*, The internal genitalia and mating behaviour of *Eurukuttarus confederata* Grt. *J. Morph.* **72** : 601–611.

——, 1943*b*, A new relationship of the bursa copulatrix to the female reproductive system in Lepidoptera. *Proc. ent. Soc. Wash.* **45** : 45–50.

——, 1944, The comparative anatomy of the internal genitalia of three Psychid moths. *J. Morph.* **75** : 251–260.

ABBREVIATIONS.

A, Accessory glands (male) ; B, Testes ; C, Seminal vesicles ; D, Vas deferens ; E, Ejaculatory duct (expanded portion) ; F, Gland (connects with the ejaculatory duct) ; G, Ejaculatory duct ; H, Penis ; I. Bursa copulatrix (monotreme) ; J, Median oviduct ; K, spermatheca ; L, Accessory glands (female) ; M, Rectum ; N, Vagina ; O, Sac-like gland (similar to F) ; P, Duplex ejaculatory duct ; Q, Cup-like structures of the testes or vasa deferentia ; R, Seminal vesicle of *T. tinctoriella* ; S, Cloacal duct. ; T, Bursa copulatrix (diplotreme) ; U, Expanded sac-like structure of the seminal duct—this sac might be a part of the bursa copulatrix ; V, Small expanded sac of the seminal duct ; W, Glandular tissue surrounding the terminal end of the seminal duct ; AA, Sac-like structure of the spermathecal duct of *T. tinctoriella* ; BB, Tube-like spermathecal gland of *T. tinctoriella* ; CC, Reservoir of the accessory-gland duct ; DD, Ovaries.

ANOPHELINE MOSQUITOES BREEDING IN FISH DAMS, POOLS AND STREAMS IN NORTHERN RHODESIA

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This paper is an account of an investigation into the species of mosquitoes breeding in fish dams, pools, streams and other works, used in the experimental "fish farming" operations at the Chilanga estate of the Game and Tsetse Control Department. Freshwater fish are becoming an increasingly important item in the diet of Central African natives, and these operations are part of the measures taken by the Northern Rhodesian Government (Vaughan-Jones, 1945) to assist in the development of the territory's inland fisheries by improved stocking, and by encouraging water conservation (and incidentally diminishing soil erosion). The question has naturally arisen of the possible increase of malaria carrying mosquitoes resulting from such measures and so anophelines have been collected regularly at Chilanga for over two years. It is, moreover, important to assess this danger, as the liberal, and possibly over-enthusiastic, use of DDT larvicide is probable in the near future and this insecticide is markedly poisonous to young fish (Pielou, 1946).

II. Species Collected.

An African mosquito searcher, under supervision, collected larvae daily, visiting each of the waters enumerated below on more or less regular rounds. Adults were bred from these larvae and identified (Evans, 1938). The resulting figures are sufficient to give a clear picture of the relation of species to the different types of water and a rough idea of the quantitative distribution. The species identified include the malaria-carrying *Anopheles gambiae* Giles (71 specimens) and *A. funestus* Giles (36), and also *A. rufipes* Gough (1,321), *A. squamosus* Theobald (516), *A. coustani* Laveran (270), *A. marshalli* Theobald (4), *A. maculipalpis* Giles (15), *A. pretoriensis* Theobald (20), *A. demeilloni* Evans (39), *A. leesoni* Evans (3), *A. pharoensis* Theobald (1) and *A. theileri* Edwards (8). The seasonal distribution of the more common of these species, irrespective of locality, is shown in Table I.

III. The Environment.

The waters inspected covered an area of about half a square mile. They consisted of a number of small and large dams and breeding pools built along about one mile of a previously existing stream. Other local waters in the area were investigated as well for the purpose of comparison. The distribution of all the species in relation to the various habitats, irrespective of date of collection, is shown in Table II. The habitats are described below.

TABLE I.

Seasonal distribution of the more common anophelines tabulated irrespective of habitat.

Species	Year	MONTH											
		J	F	M	A	M	J	J	A	S	O	N	D
A. gambiae ...	1944	—	—	11	1	—	—	—	—	—	—	—	*
	1945	1	13	26	—	—	—	—	—	—	—	—	—
	1946	1	0	2	8	8	—	—	—	—	—	—	—
A. funestus ...	1944	—	—	1	6	6	5	6	1	—	—	—	*
	1945	—	—	2	—	—	—	—	3	—	2	—	—
	1946	1	—	2	1	—	—	—	—	—	—	—	—
A. rufipes ...	1944	—	—	5	7	8	4	5	6	27	17	57	*
	1945	166	178	73	6	33	55	37	4	3	25	136	113
	1946	98	101	23	47	87	—	—	—	—	—	—	—
A. squamosus ...	1944	—	—	25	14	20	7	8	5	10	5	20	*
	1945	39	40	14	0	3	31	51	2	1	6	3	30
	1946	33	44	20	35	50	—	—	—	—	—	—	—
A. coustani ...	1944	—	—	6	1	0	6	4	29	22	7	6	*
	1945	7	0	21	7	8	3	0	10	9	2	0	0
	1946	0	3	34	60	25	—	—	—	—	—	—	—

* No collections were made in December, 1944.

TABLE II

Totals of anophelines collected from March, 1944, to May, 1946.

	gambiae	*funestus*	*rufipes*	*coustani*	*squamosus*	*demeilloni*	*pretoriensis*	*maculipalpis*	*theileri*	*leesoni*	*marshalli*	*pharoensis*
Main Dam	1	1	28	17	125	—	—	1	1	—	—	1
Reserve Dam	1	—	18	21	20	3	3	—	—	—	—	—
Small Dam A	1	—	17	38	3	—	—	—	—	—	—	—
Small Dam B	—	—	10	1	2	—	—	1	—	—	—	—
Pool No. 1	5	1	220	15	175	—	1	1	6	—	—	—
Pool No. 2	—	—	252	8	62	—	—	—	—	—	—	—
Pool No. 3	—	—	70	4	15	—	—	—	—	—	—	—
Pool No. 4	2	1	22	7	12	—	—	—	—	—	—	—
Pool No. 5	6	1	61	1	8	—	—	—	—	—	—	—
Pool No. 6	2	—	116	—	24	—	1	—	—	—	—	—
Pool No. 7	—	—	—	—	1	—	—	—	—	—	—	—
Pool No. 8	33	—	174	—	12	—	—	—	—	—	—	—
Pool No. 9	—	—	136	5	40	—	—	—	—	—	—	—
Dam Wall Seepage ...	9	13	25	26	3	33	12	11	—	—	2	—
Water Supply Ditches ...	—	3	6	16	1	2	—	—	—	1	—	—
Musambang'ombe Stream	—	7	123	53	10	—	—	1	—	—	—	—
East Stream	—	9	39	54	2	1	—	—	—	2	2	—
Temporary Rock Pools*	4	—	—	4	1	—	2	—	1	—	—	—
Hoof Prints*	7	—	4	—	—	—	1	—	—	—	—	—
Totals	71	36	1321	270	516	39	20	15	8	3	4	1

* A few collections only.

(*a*) *Main Dam.*—This is an exposed stretch of water, whose surface is frequently disturbed by wind, varying in area from three to seven acres according to season and held back by an earth dam of the type common in Africa. There is practically no shade except a little, at high water levels, from phragmite reeds and grasses near the edges. The banks are fairly clear cut and unbroken and any extensive floating debris, such as occurs after heavy rain, is removed to prevent the blocking of the spillway. At high water the dam has shallow margins and a deeper central part (over 20 feet) ; in the dry season the dam is confined to some 3 to 5 feet of water in the latter portion. The fish present are mainly Kafue "Bream" (*Tilapia kafuensis*) and Bluegill Sunfish (*Lepomis macrochira*). The solitary specimen of *A. gambiae* (Table II) recorded in March, 1944, appears to have been taken from within a mat of floating debris. The single example of *A. funestus* was taken from the dam margin among semi-submerged grass at high water level.

(*b*) *Reserve Dam.*—This dam is similar to the main dam, its function being to keep up the level of the latter. Recently constructed, it has never filled fully and before January, 1946, consisted of small patches of clear water among luxurious grasses and reeds. After this date it filled quickly with the onset of heavy rains and resembled the main dam though on a smaller scale.

(*c*) *Small Dam A.*—This dam is a relatively deep pool with a small surface area (about 400 square yards) rather heavily shaded by trees except near the dam wall. The one *A. gambiae* was taken from shallow, sunlit water at the commencement of the spillway. Elsewhere it is a steep sided pool.

(*d*) *Small Dam B.*—This is a dam that is shallower but more extensive than the former and only lightly shaded. Large numbers of young fish are present, mainly Kafue Bream and Bluegill Sunfish ; the water is clear on the whole with no floating vegetation. Very few anophelines were found probably because of the abundance of the small fish.

These four dams are all built spaced out along about one mile of the original stream. The following nine breeding pools are situated below the wall of the main dam.

(*e*) *Pool No.* 1.—This pool is about one-third of an acre in extent with clean cut banks, but the uneven nature of the bottom leads to the pool dividing up into bays during the dry season. The maximum depth is about 12 feet, but there are always these shallow portions even in the wet season. There is a dense growth of water-weed (*Chara*) and also swamp grass (*Leersia hexandra*) and marginal Kikuyu grass ; small fish are present, Bluegill Sunfish having been exceptionally numerous in 1944. Seven species of anophelines were recorded, presumably due to the varied nature of the pool ; the dense aquatic vegetation apparently protects them from the fish although Bluegill Sunfish do not, in any case, seem as effective larva eaters as *Tilapia.*

(*f*) *Pools Nos.* 2 *and* 3.—These are two small pools of about 300 to 400 square yards, each with sheltered and generally clear water and clean-cut banks. Pool 3 has a maximum depth of 3 feet, pool 2 being rather deeper in places. A varied selection of small fish is present, including *Tilapia*, *Barbus* and exotic *Gambusia affinis*. Pool 3 was dry for the last six months of 1945. In January, 1946, it was refilled and four large tench introduced. No *A. gambiae* or *A funestus* were recorded.

(*g*) *Pool No.* 4.—This pool is approximately 100 yards in area with high clear-cut banks and with very scanty submerged vegetation ; there is no shade. No fish were put in this pool, which has been dry for long periods. The *A. gambiae* and *A. funestus* were recorded when the pool was being made.

(*h*) *Pool No.* 5.—Of about 300 square yards, this pool was remade into pools 6, 7, 8 and 9 in January, 1945. It was sheltered, shallow and with low grassy banks.

(*i*) *Pool No.* 6.—A pool of about 150 square yards with considerable submerged vegetation and low banks. It is very similar to pool No. 9, but has young Bluegill instead of *Tilapia*. These fish seem much less effective at keeping down mosquito larvae, which were recorded throughout almost the whole period that these fish were present.

(*j*) *Pool No.* 7.—A very small pool (about 12 square yards), fairly free of weed and shallow. This pool was almost always overstocked with young *Tilapia* and practically no mosquito larvae were recorded.

(*k*) *Pool No.* 8.—This is a small shallow pool very similar to pool No. 7, but without any fish ; it evaporates rather quickly in the dry season. It is a typical *gambiae* pool and, in the absence of fish, produced large numbers of this species in the early months of the year.

(*l*) *Pool No.* 9.—A pool of about 100 square yards with dense moss-like submerged vegetation to within a few inches of the surface and low banks. This pool had a very high density of *Tilapia kafuensis* most of the time and during this period no larva were recorded. The young of this fish seem most effective as larva eaters if no excessively obstructive aquatic vegetation is present. All the anophelines recorded in Table II were obtained in three months when no fish were present.

(*m*) *Dam Wall Seepage*.—There is a continuous percolation of seepage water from underneath the main and reserve dam walls. This water flows out on to the surface at the foot of each wall. It passes slowly through the short Kikuyu grass, planted around and on the dam walls, forming occasional puddles. The seepage water is rather heavily shaded in parts but open to the sun elsewhere. *A. funestus* was recorded and *A. gambiae* early in 1944, probably in the seepage puddles.

(*n*) *Water Supply Ditches*.—These are an essential part of the works and are used for filling the breeding pools. The main ditch is supplied from a cock at the foot of the dam wall. The seepage from under the dam also finds its way into the ditch. The ditches were regularly dried out, but a few *A. funestus* were recorded.

(*o*) *Rock Pools*.—These were formed temporarily early in 1946 in the process of building a new spillway for the reserve dam through rocky ground. Only three or four collections were made, but a high proportion of *A. gambiae* was obtained.

The waters described above are artificial ones; those described below are natural habitats. Systematic records are obtained only for (*p*) and (*q*).

(*p*) *Musambang'ombe Stream.*—This describes the parts of the original stream remaining between the various dams. It is a small perennial stream generally with shallow, clear water. In parts it is deeply ravined as a result of rapid flow in the rainy season, and much of it is shaded by trees. There are stretches suitable for *A. funestus*, particularly when the water flow slackens after the rains.

(*q*) *East Stream.*—This is a very shallow, seasonal and intermittent dambo head stream, following a rather ill-defined marshy course near its source. Here the water is frequently completely exposed to the sun, but elsewhere is shaded by tall grasses. In the dry season the stream is reduced to marshy pools and later in the year dries up completely. It is not part of the fish breeding establishment and, being unmodified, served as a rough control.

(*r*) *Hoof Prints.*—Two casual collections of larvae from cattle hoof prints were made in April, 1946. One yielded 7 *A. gambiae.*

IV. Discussion and Summary.

The records obtained do not show any great danger from *A. gambiae* and *A. funestus*. The small fish breeding pools might well be expected to produce the former species, but the young fish themselves would seem to keep down *A. gambiae*, whose marked preference for sunlit waters probably puts it at a great disadvantage when such predators are present. Idle pools devoid of fish are dangerous, however, as also is surface seepage water at the foot of dam walls. Apart from these cases, however, ubiquitous puddles and hoof prints probably produce far more *A. gambiae* than a whole series of fish breeding pools. *A. funestus* is also evident in weedy seepage water and in the water furrows, which can however be dried out periodically. They are no more numerous than in neighbouring streams. There are only a few isolated records in the dams and pools. As regards non-malarial species, *A. rufipes* is most widespread both in numbers and in choice of habitat; it occurred in every type of water investigated. *A. squamosus* is also widespread but confined to still waters; in spite of an overall abundance there are remarkably few records from the streams and moving water in seepages or water furrows. With *A. coustani* the position is largely reversed, and it occurred freely in streams and is notable even in the small area of slowly moving seepage water; there are, however, an appreciable percentage of records from pools and dams. The records of *A. demeilloni*, *A. pretoriensis* and *A. maculipalpis* are almost entirely from seepage water, which produced more species than any other habitat.

V. Conclusions.

1. A "fish farming" establishment in general does not increase the dangers from malarial mosquitoes.

2. Large fish dams with an exposed stretch of water are unlikely to favour the increase of *A. gambiae* and *A. funestus* if the banks are comparatively clear cut and unshaded.

3. Small, unshaded permanent breeding pools of an area of 100 square yards or more are safe, particularly if kept permanently stocked with fish.

4. Very small shallow breeding pools are potentially dangerous as typical *A. gambiae* sources because young fish are unlikely to be kept permanently in them. When the young fish are all removed such pools should be dried out.

5. Inevitable seepage water from under dam walls is a source of *A. funestus*, and associated puddles of *A. gambiae*. The solution lies mainly in sound dam construction so as to reduce this seepage.

6. Water supply furrows or ditches may produce *A. funestus*; the water should be regularly shut off to allow them to dry out.

ACKNOWLEDGEMENTS

This work was initiated by Mr. T. G. C. Vaughan-Jones, Director of the Game and Tsetse Control Department. We are grateful to Mr. G. G. Robinson, Medical Entomologist, for the anopheline identifications up to September, 1944, and these include the several which are new records for this country. We are also grateful to the Director of Medical Services for the loan of a trained African mosquito searcher.

REFERENCES.

EVANS, A. M., 1938, *Mosquitoes of the Ethiopian Region.* **2.**

PIELOU, D. P., 1946, *Nature, Lond.* **158:** 378.

VAUGHAN JONES, T. G. C., 1945, *Report of the Game and Tsetse Control Department for* 1944. Government Printer, Northern Rhodesia.

THE EARLY STAGES, BIONOMICS, COLLECTING AND REARING OF *NESOSISYPHUS* VINSON (COLEOPTERA : COPRINAE)

By J. Vinson, F.R.E.S.

(*Curator, Mauritius Institute.*)

This genus, which has been recently described,[1] comprises four species, all from Mauritius : *N. regnardi* (Alluaud, 1898), *N. vicinus* (Vinson, 1939), *N. pygmaeus* and *N. rotundatus* Vinson, 1946.

The information available on these beetles is still rather fragmentary, but as it will not be possible to make a further study of them for a long time to come, the results hitherto obtained are given now.

Description of the early stages.

Specific variation seems to be very slight in the early stages of the beetles under consideration, so that the following description will be mainly generic. Any possible specific distinctive features that were recognised are, however, recorded.

Egg white, oval, comparatively large, measuring 1·45 × 0·95 mm. in *N. regnardi* and 1·15 × 0·90 mm. in *N. pygmaeus* ; not seen in the two other species (*vicinus* and *rotundatus*). The dung pellet in which the egg is laid measures from 6 to 7 mm. diameter in *N. regnardi* and 4 to 6 mm. in *N. pygmaeus.* When found in nature this dung pellet is enclosed in a crust of variable hardness forming the "ball" (fig. 1). This ball is slightly oval or pear-shaped and measures about 10 × 12 mm. in *N. regnardi.* It has not yet been authenticated in the other species.

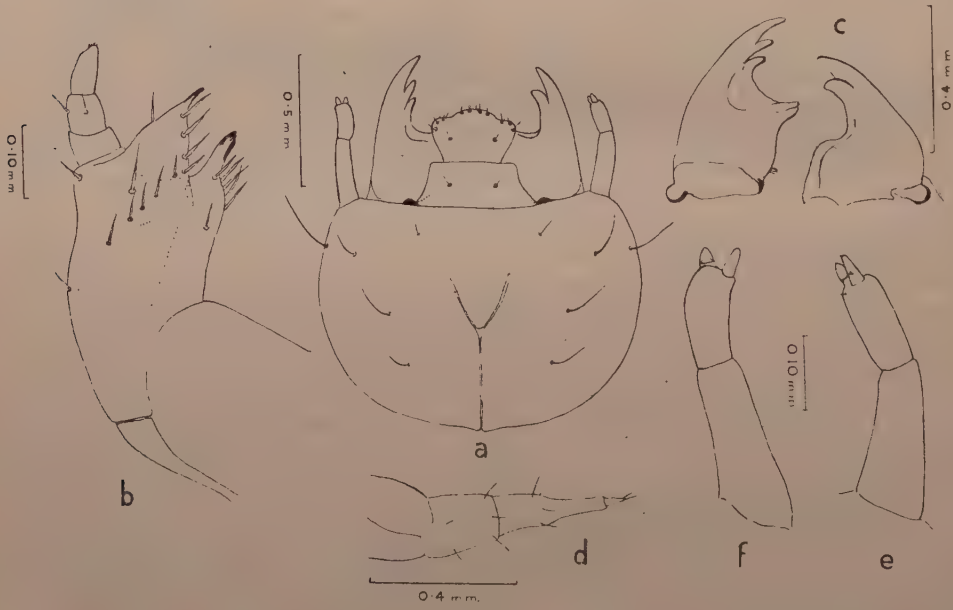

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Fig. 2.—Larvae of *Nesosisyphus* spp. *a*, *N. regnardi* (Alluaud), head ; *b*, *N. vicinus* (Vinson), left maxilla ; *c*, *N. vicinus*, mandibles ; *d*, *N. vicinus*, leg ; *e*, *N. vicinus*, antenna ; *f*, *N. regnardi*, antenna.

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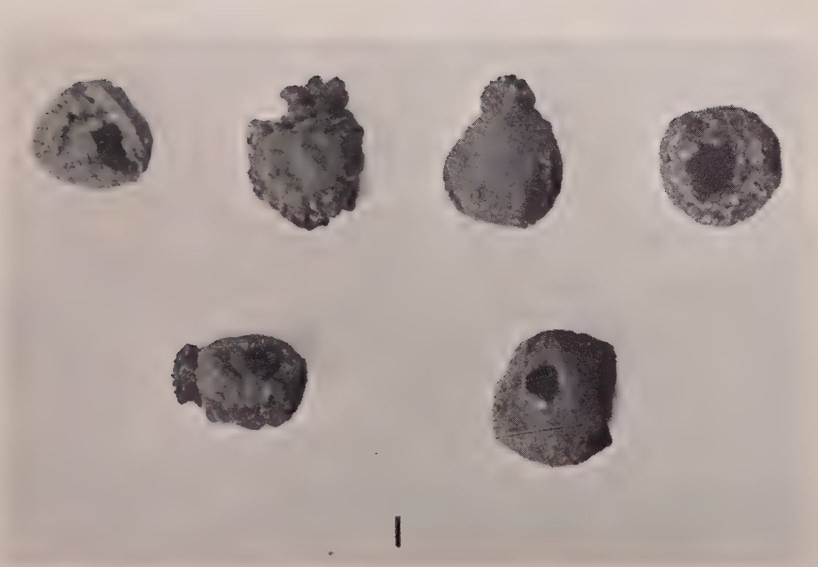
[1] 1946, *Proc. R. ent. Soc. Lond.* (B) 15: 89.



Phot. G. P. Pitot

FIG. 1.—Balls of *Nesosisyphus regnardi* (Alluaud), slightly enlarged. Those on the extreme right and left of the top row are shown in section. The outline of the dung pellet can be seen in the section on the left.

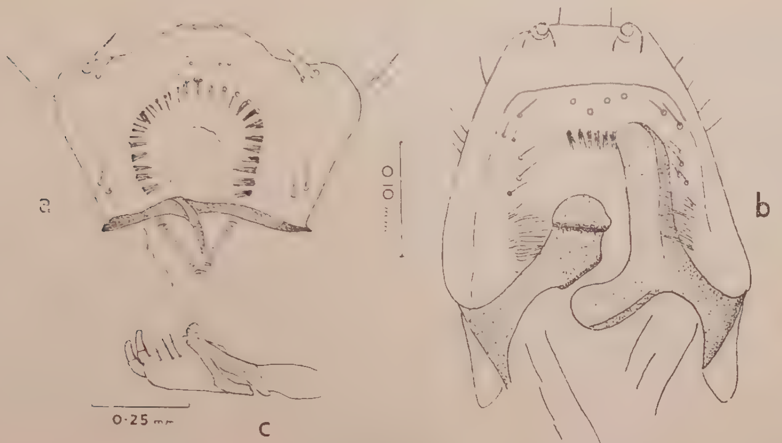


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FIG. 3.—Larva of *Nesosisyphus vicinus* (Vinson). *a*, labrum, ventral surface, showing epipharynx ; *b*, labium, upper surface, showing hypopharynx ; *c*, labium, side view.

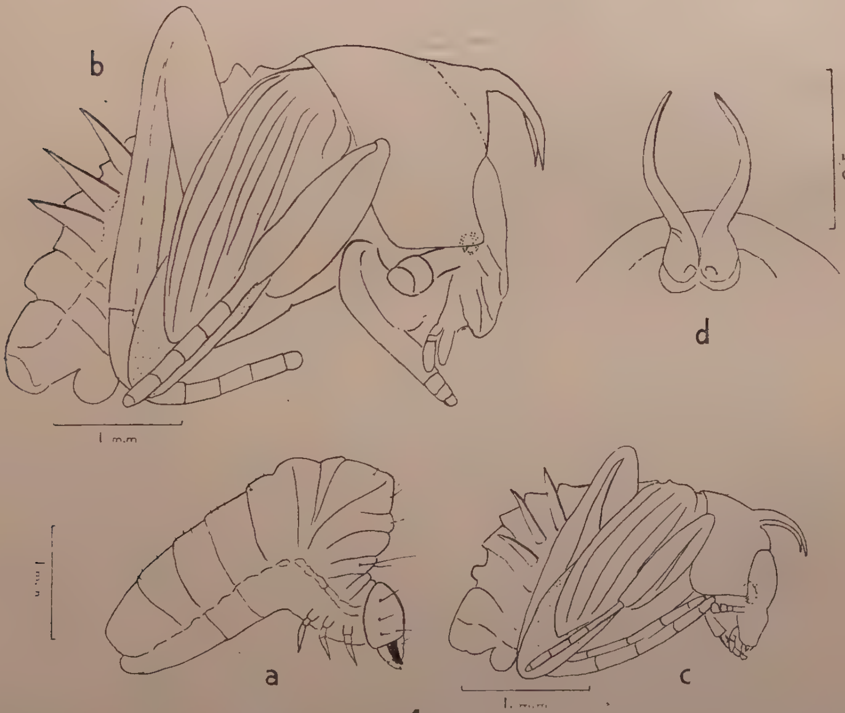

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FIG. 4.—*a*, larva of *N. regnardi* (Alluaud) ; *b*, pupa of same ; *c*, pupa of *N. pygmaeus* Vinson ; *d*, pronotal processes of same.

Larva : head (fig. 2, *a*) pale testaceous, nearly white, with a Y-shaped suture, maximum breadth in full-grown larvae : 1·20 mm. in *N. regnardi* and 0·86 mm. in *N. pygmaeus.*

Chaetotaxy of the head as follows : frons with two moderately elongate setae behind the condyles ; epicranium with a long lateral seta on each side at about the anterior fourth, and three pairs of fairly long ones on each epicranial lobe, placed on a line converging behind, first pair at anterior fourth, second at about half, and third at about two-sevenths from base. Clypeus with one pair of rather short setae near the middle. Labrum with one pair of short setae at middle and about ten on the apex (three on each lateral lobe and four on the median one) ; underside (epipharynx) with one pair of unequal, fairly stout setae on each lateral lobe and pointed obliquely inwards, a second smaller pair on each side of the basal region. Antenna (fig. 2, *e, f*) stout, 3-segmented, first segment longest, second about two-thirds of first, third very minute ; an accessory lobe is also present on the second segment, close to the third one and approximately equal to it in size. Mandibles (fig. 2, *c*) : left tridentate towards apex, right bidentate. Labrum (fig. 3, *a*) roughly trilobate ; epipharynx, as figured. Maxillae (fig. 2, *b*) with galea and lacinia rather sharply pointed, palpus apparently 3-segmented. Labium (fig. 3, *b*) with two segmented palpi, incurved vertically upwards, hypopharynx as figured. Legs (fig. 2, *d*) apparently 4-segmented, last segment very small, bearing two terminal setae, penultimate segment longest, constricted from the middle. Spiracles indistinct.

Apart from the difference in the size of certain species, no specific features could be detected, but it should be noted that only one larva of *N. vicinus* has been available for examination and that the early stages of the rare *N. rotundatus* are still unknown.

Pupa (fig. 4, *b, c*) completely glabrous, cuticle white, eyes purplish. Pronotum bearing near the anterior third a pair of horn-like processes (fig. 4, *d*) directed forwards and curved downwards ; these processes are borne on a distinct elevation and their dilated bases are close together. Abdomen apparently 8-segmented dorsally but segmentation rather indistinct at base and apex, each segment crested transversely and longitudinally in the middle. Segments 3, 4 and 5 bear a spine-like process on each side. Last segment (pygidial) narrowed, dilated at apex where a dorsal fold is present and bearing ventrally a globular pouch which contains the genitalia. Hind-legs crossing each other near base of tarsi which are directed forwards ; femoral-tibial junction projecting dorsally between elytral sheath and first abdominal spine-like process. Wings : elytral sheath reaching about middle of intermediate tarsi, hind-wing sheath longer than elytra, reaching about apex of middle tarsi.

Only the pupae of *N. regnardi* and *N. pygmaeus* are known and they differ as follows :

N. regnardi (fig. 4, *b*). Length 4·0 to 4·4 mm. ; maximum width (on elytral sheaths) 3·0 mm. Apex of hind tarsi reaching base of mid-femora, hind-wing sheath not quite reaching apex of mid-tarsi.

N. pygmaeus (fig. 4, *c*). Length 2·5 to 3·5 mm. ; maximum width 2·0 mm. Apex of hind tarsi reaching base of front legs, hind-wing sheath a little longer than mid-tarsi.

It is important to note that, although the hind-wings are considerably reduced in the adult of *N. regnardi*, the hind-wing sheaths are normally developed in the pupa.

Bionomics.

The beetles depend for their subsistence on an introduced species of monkey (*Macaca* sp.) It is highly probable that before the arrival of this mammal in the island they lived on bird excreta. This question will be discussed more fully when dealing with the ecology of these insects.

Shortly after the host's excrement has been deposited, the beetles arrive in varying numbers, dividing the mass into fragments, which are rolled away either for immediate consumption or for the construction of the pellets for the larvae. In the latter case a minute cell is made by the beetle at one end of the pellet, an egg laid in it and the cell closed, the pellet thus becoming pear-shaped.

The "nesting" habits of Coprine beetles in general are well known : a chamber is excavated underground at varying depths and the ball or balls placed in it. However, in the case of *Nesosisyphus regnardi,* and very probably in the three other species too, no excavation is made, the pellet being simply dragged under some shelter, either a stone or rock, a fallen log or branch, or very often under dead leaves accumulated on the ground in densely wooded places. After oviposition the pellet is coated with a thick layer of some clayey material which transforms it into a fairly large ball (fig. 1).

In dry weather or in dry situations this ball is of very hard consistency, but in damp places it is quite friable. Which of the two is the normal texture it is difficult to say, but when opened the hard balls are often found to contain dead beetles which have been unable to make their way out after reaching maturity, suggesting that the friable condition is more advantageous. It has not been possible to determine whether both sexes take part in the rolling of the pellet or in the making of the ball, or if the work is performed by the female only. But the habits of the genus appear to be so primitive that it is rather doubtful whether parental care has reached the advanced stage in which the male collaborates.

The life-cycle of one of the species (*N. pygmaeus*) has been worked out completely. The egg stage was found to last 3 days, the larval stage 19 to 20 days and the pupal 10 to 11 days. From the rearings in confinement it appears that the female will not start egg-laying until one month after emergence. It will therefore be seen from the foregoing results that the cycle from egg to adult lasts 30 to 34 days and from egg to egg about two months. This was in November–December, 1944, when the mean temperature of the locality where the rearing was carried out (Moka) was approximately 22° C.

Under artificial conditions the adult life was found to last at least two months. The normal brood of a single female has not been ascertained.

The adults are found at all times of the year, possibly in greater numbers in November–December (*i.e.*, just before the rainy season) than in April–May (*i.e.*, at the end of it). This might be due to the heavy showers, frequently accompanied by flooding of the mountain slopes which probably destroy large numbers of the beetle in all stages, but precise observations on the relative abundance of these insects at different periods of the year are still so incomplete that to draw a conclusion at this stage would be premature.

Collecting.

When monkey dung is found on the ground in favourable localities the capture of some *Nesosisyphus* is nearly always assured. The beetles are found under the mass or near it ; when disturbed they try to escape by forcing themselves into the ground or sometimes by taking wing in the case of *N. pygmaeus*. The collector should not, however, rely solely on this direct method : very often no monkey dung is met with and as a result not a single beetle is seen. In this connection it is interesting to note that when the genus was first discovered in Mauritius on Mt. Pouce by Messrs. Alluaud and Regnard in 1897, a single individual of the species subsequently named *Sisyphus regnardi* was taken, and until fairly recently it was considered extremely rare. In my own case it was only on the sixth collecting trip in that locality that I accidentally came across the first example of this species. At the present time, with the simple methods described below, hundreds of specimens can be quickly and easily secured. These methods are based on the use of fowl dung as bait, this having been found to be highly attractive to the beetles. The investigator is thus enabled to detect their presence in places where they would have been otherwise overlooked and, conversely, to discover which localities are definitely without them. These methods should prove useful for population studies and also for testing the relative attractiveness of different substances.

The fowl dung can be used directly or in traps. In the first case a certain quantity of the excrement is placed on the ground in a suitable place and the beetles come to it within a few hours or even earlier. In the second case the bait is placed in very simple traps made of ordinary cylindrical cigarette tins $3 \times 2\frac{1}{2}$ inches. A hole $1\frac{1}{4}$ inches in diameter is perforated in the lid and a tin funnel approximately of the same diameter as the lid and with an exit hole of about $\frac{1}{2}$ inch is fitted to the lid. The bottom of the tin is pierced with minute holes to allow the percolation of water in case of rain. The trap is baited and buried in the ground in such a way that the top of the funnel is level with the surface of the soil. It is advisable to conceal the whole apparatus, for instance by means of a stone supported on each side. This will be a protection not only against rain but also against the curiosity of human beings or even monkeys who will almost certainly disturb the trap if they happen to discover it accidentally. The traps can be examined after a few hours or a few days. They should not be left unattended for more than four or five days, because the bait soon liquefies, especially in rainy weather, and the captured beetles become entangled in it, decay rapidly and are lost. It should be possible to avoid this by preventing the beetles from coming into direct contact with the bait by means of some simple barrier.

Another trap has been devised in which there is no funnel at all : the bait is fixed under the lid by means of a piece of muslin and the beetles have access to the apparatus either through a series of $\frac{1}{4}$ inch holes perforated around the tin at about 1 inch from the top, or through two horizontal slits $\frac{1}{4}$ inch wide, made on each side. These traps, the height of which can be increased if found too low, are also buried so that the holes or slits are level with the surface of the ground. The beetles which are attracted by the smell of the bait try to reach it by entering through the holes or slits and fall to the bottom. If the surface of the metal is not corroded they are unable to climb up the sides and so remain imprisoned. However, the results with such traps were not as good as those obtained when using the simple funnel type, one of which, for instance, yielded as many as fifty *N. regnardi* after less than eight hours. One reason for the failure is that in practice it is very difficult on sloping and rocky ground to level the soil exactly with the side holes or slits.

Laboratory Rearing.

Rearing was carried out in ordinary cigarette tins of about 250 c.c. capacity, closed by a piece of muslin fixed by means of a rubber band. Plaster blocks, with a depression 2½ inches diameter and ½ inch deep, were also used as well as blocks open on both sides. In each case pieces of glass secured by rubber bands were used to close the opening or openings as the case might be.

A certain quantity of wet soil, about 50 to 75 grammes, was placed in each container. Soil rich in organic matter was used for the purpose ; it was sifted and sterilised by immersion in boiling water with subsequent drying in the sun, so as to destroy minute noxious organisms such as mites. Coralline sand was also tried but unsuccessfully. From two to four adults were placed in each container and some fowl dung given to them. Unfortunately, as the sexes cannot be distinguished readily on external characters, there was no means of ascertaining if a pair or pairs had been thus segregated and all that could be done was to rely on chance. Segregation is necessary because when too many individuals are placed together they destroy their egg pellets mutually. The containers were then placed in large desiccator vessels with water at the bottom. Every day, or every two days, the containers were examined, fresh food supplied, and any pyriform dung pellet found in them removed. These pellets were placed in a small plaster block $3\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$ inches in which a series of holes, each just large enough to receive one pellet, had been excavated. Each hole was numbered for life-cycle determinations. A piece of glass $3\frac{1}{2} \times 2\frac{1}{2}$ inches fastened with a rubber band was placed on the block to close the holes and the whole was kept in a small desiccator vessel containing water. Some of the pellets were opened from time to time to follow the development of the insect and closed again, very often without ill effects. In some cases a dung pellet had to be made artificially to replace a broken one and this was often successful.

The rearing method above described was used with success in the case of *Nesosisyphus pygmaeus*, but it was inadequate for the other species. It was only possible to obtain one or two eggs from *N. regnardi* and *N. vicinus* and the resulting larvae did not survive. Some adjustment appears necessary, either in the food, the humidity or the temperature. With regard to the humidity I had started a series of experiments using sulphuric acid as regulating agent, but partly through lack of time, partly because of a troublesome invasion of parasitic mites, they were not concluded. With regard to the temperature, it may have fluctuated too much in the room where the results were being observed. In order to obviate this, steps had to be taken to carry out the breeding at about four feet underground, in an excavation made on the side of a trench, but the violent cyclone of January 1945 destroyed all the experiments and it has not been possible to resume the work.

SEASONAL VARIATIONS IN THE NUMBERS OF SOME WAREHOUSE INSECTS.

By O. W. Richards, M.A., D.Sc., and N. Waloff.

During the study of a population of *Ephestia elutella* (Hübner) living on bulk wheat in a London granary (Richards and Waloff, 1946), the numbers of the moth were estimated by counts on 39 sample areas, representing about 6·0 per cent. of the surface of the room studied. In the course of the counts the numbers of other warehouse insects were noted. The estimates are less reliable than in *Ephestia* both because the other species were rarer and the same degree of attention was not paid to them, and because, in some species, different methods of sampling would be more appropriate. The interest of the observations lies principally in the light they throw on the seasonal history of the species. Observations were made about twice a week from 18.v. to 12.viii.43, and once a week from 12.viii. to 18.xi.43 and from 10.v to 7.xii.44. The conditions in the room mainly studied are described in Richards and Waloff (*loc. cit.*), but in 1943 some other rooms were also examined, all containing other lots of wheat. The species are dealt with in systematic order.

Lepidoptera.

1. Pyralididae, *Pyralis farinalis* (L.).

The adults occurred in very small numbers on four floors. In 1943 it appeared from 10 to 29.vi. and on 10.viii. ; in 1944, on 21.vi., 12.vii. 1.viii. and on 31.viii.

2. Phycitidae, *Ephestia kühniella* Zeller.

Although this species is primarily a mill-pest, it also occurs in small numbers on bulk wheat. The adults were seen in 1943 on 3–12.viii. and 14.x.–4.xi. ; in 1944, on 3.vii., 17.viii., 7–14.ix. and 5.x.

On 29.ix.43, 100 rolls of corrugated paper were exposed on the grain for a week to trap wandering larvae. The rolls were kept in the granary and samples were examined between 8.xi.43 and 14.vi.44. Small numbers of *E. kühniella* were found in these samples, 61 pupae in all. Evidently there is no larval diapause as in *E. elutella*, but the pupa can withstand winter temperatures, at least if they are not too low. In unheated warehouses, the life-cycle seems to be irregular and moths can probably be found in almost any month of the year.

3. Galleriidae, *Aphomia gularis* (Zeller).

This moth is more characteristic of other products, such as nuts, but was once seen on 29.vi.43 in a room containing wheat.

4. Oecophoridae, *Hofmannophila pseudospretella* (Stainton).

The moth was seen in 1943 on almost every visit from 25. v. to 23.ix., but there appeared to be two peaks, one 3–8.vi. when nearly two hundred were present in the room, the other 3–5.viii. when somewhat over two hundred occurred. In 1944 it was seen from 6.vi. to 19.vii. (peak 3.vii.) and 17.viii.–7.ix. (peak 27.viii.). In neither year were any seen later than 23.ix.

5. *Endrosis sarcitrella* (L.).

The moth occurred in small numbers from 18.v. to 29.vi.43 and from 17.v. to 29.vi.44 and then again in 7–21.x.43 and 14.ix.44. One moth was seen on 22.vii.43.

6. Tinaeidae, *Tinaea granella* (L.).

The moth occurred in small numbers from 18.v. to 6.vii.43, except that over seven hundred occurred in a room with heating English oats. One or two moths were again seen on 7–21.x.43. In 1944 moths were seen from 24.v. to 6.vii. with a peak of 750 on 6.vi. None were seen in the autumn in 1944.

Coleoptera.

7. Dermestidae, *Dermestes lardarius* L.

In 1943 only a few adults were seen from 3.vi. to 6.vii. and one on 29.ix. One larva was seen on 29.vi.

In 1944 small numbers of adults occurred from 10.v. to 25.vii. and then again from 10.x. to 7.xii. The larvae occurred between the two adult appearances, from 17.viii. to 10.x. The maximum number was about 140 on 7–14.ix. This coincides with the period when full-grown larvae of *Ephestia elutella* are wandering in very large numbers. There is little doubt that the *Dermestes* larvae feed on the numerous *Ephestia* larvae which are dying of "Wilt."

8. Ptinidae, *Ptinus tectus* Boield.

In 1943 the adults were seen from 3.vi. to 11.xi., with a possible maximum of about 300 beetles on 10.viii. It is certain that in this species only a very small proportion of the beetles present were detected by the sampling methods used for *Ephestia*.

In 1943 thirty trays of grain (see Richards and Waloff, *loc. cit.*) were exposed on the surface of the bulk to measure oviposition from 24.vi to 19.viii. The grain was changed every week and incubated to obtain larvae large enough to count. From the known area of the trays (about 22 square feet) and of the grain bulk (5,250 square feet) it was possible to calculate the number of *Ptinus* larvae added to the room in successive weeks. The figures were as follows :—

Date … …	24.vi.– 1.vii.	1.vii.– 8.vii.	8.vii.– 15.vii.	15.vii.– 22.vii.	22.vii–. 29.vii.	29.vii.– 5.viii.	5.viii.– 12.viii.	12.viii.– 19.viii.
No. of *Ptinus* larvae added to the grain	0	0	2,400	34,300	22,800	8,400	5,800	5,500

In 1944 adults were found in small numbers from 17.v. to 12.vii. and then in larger (up to 200) but variable numbers up to 7.xii. Trays were only exposed from 6–12.vii. and 12–19.vii., and in these two weeks it was estimated that the numbers of *Ptinus* larvae added to the grain were 14,300 and 10,400, respectively.

The common Pteromalid parasite of *P. tectus*, *Dimachus discolor* (Walker) (CHALCIDIDAE) occurred in small numbers throughout the season.

9. TENEBRIONIDAE, *Tenebrio molitor* L.

This species always occurred in very small numbers; adults 3.viii.–26.viii.43 and 25.vii.–17.viii.44 and larvae 29.vi.43 and 4.xi.43; in 1944 no larvae were seen early in the year, but they occurred 16–22.xi. This suggests a yearly cycle with the adults occurring in the late summer.

10 and 11. CURCULIONIDAE, *Calandra granaria* (L.) and *C. oryzae* (L.) (small strain).

The adult weevils occurred in very small numbers throughout the year, but as they are very long lived the observations do not throw much light on the seasonal cycle. There appears, however, to be a tendency for the adults to appear in rather large numbers on walls, etc., in the autumn (x.–xi.) when the temperature is falling.

COPEOGNATHA.

12 and 13. *Trogium pulsatorium* (L.) and *Liposcelis* sp. (det. Mr. E. Broadhead).

These two species both occurred, but the former seemed to be much more common. In 1943 they occurred in very large numbers from 29.vi. to 2.ix.; after that their numbers fell off and none were seen after 14.x. In 1944 the numbers were much smaller and they were only noticed from 12.vii. to 7.ix.

DIPTERA.

14. SCENOPINIDAE, *Scenopinus fenestralis* (L.).

The larva of this species is predacious on other insects and lives in dust on floors, window-sills, etc. In 1943 adults were seen from 29.vi. to 2.ix. and in 1944 from 6.vii. to 7.ix. The peak in numbers on 19.vii. 44 was about 650 flies. On 17.viii.44 a recently emerged fly was seen with its wings not fully expanded. On 3.viii.43 a fairly large larva was found in a sample of grain. Three larvae found on a window-sill 13.v.43 produced adults, ♀ 29.vi., ♂ 2.vii. and ♀ 4.viii.

15. Other Diptera.

A number of flies are found regularly in small numbers on walls and windows and probably breed in the granary. Such are *Anisopus fenestralis* (Scopoli) (ANISOPODIDAE), ♀ 13.vii. and 14.x.43; *Megaselia giraudii* (Egg.) (*rata* auct.), ♀ 5.viii.; *M. rufipes* (Meigen), ♀ 7.ix., 2♂ 2♀ 26.x.; *M. pleuralis* (Wood), 2♀ 22.vii. (PHORIDAE). At least *M. rufipes* seems to be attracted to the bodies of dead *Ephestia* larvae; *Medetera truncorum* (Meigen), ♀ 17.vi., 3♀ 1.vii., ♂♀ 13.vii., ♀ 3.vii., ♂ 5.viii.; *M. diadema* (L.), ♂ 5.viii. (DOLICHOPODIDAE). Both the adult and the larva of *Medetera* feed on small insects and *M. truncorum* is regularly found inside the granary as well as on its outer walls ; *Helina uliginosa* (Fallen), 2♂ 5.viii. (MUSCIDAE). The larva is predatory on small caterpillars, etc.

HEMIPTERA.

16. *Lyctocoris campestris* (Fabricius).

This bug occurred in very small numbers on 29.ix.–11.xi.43 and 14–21.ix.44. It may perhaps feed on *Ephestia* larvae as its appearance coincides with their wandering period.

NEUROPTERA.

17. *Chrysopa albolineata* Killington.

A third instar larva of this species (det. Dr. F. J. Killington) was found on a window-sill. Although the normal food is various species of aphides, it can probably maintain itself on other small insects. A hibernating adult of *C. carnea* Stephens ♀ was found on 14.x.43.

THYSANURA.

18. *Lepisma saccharina* L.

One specimen was seen on 13.vii.43.

REFERENCE.

RICHARDS, O. W., AND WALOFF, N., 1946, The Study of a population of *Ephestia elutella* Hübner (Lep., PHYCITIDAE) living on bulk grain. *Trans. R. ent. Soc. Lond.* **97** : 253–298, 11 figs.

BOOK NOTICES.

Introducing Bee-Keeping. By H. J. Wadey. 8vo. Bognor, Sussex. (John Crowther Ltd.) [1946.] Pp. 74, text illust. Price 5s. 0d.

This little book, which is intended for the novice, is well produced and abundantly illustrated with photographs. In addition to making very interesting reading, the work is informative and contains practical hints to the experienced bee-keeper, as well as advice to the beginner. While the pleasure and profit of bee-keeping are the main theme of the book, the author has not omitted sober advice for the over-enthusiastic beginner. A useful glossary completes the work.

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——. 1936. New species of COCCIDAE. *Trans. R. ent. Soc. Lond.* **84** : 901-936.

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1947

WEDNESDAY, May 7
,, June 4
,, October 1, 15
,, November 5, 19
,, December 3

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